Digital Signal Processing (18-491/18-691)
Spring Semester, 2024

MATLAB Solutions to Problem Set 2

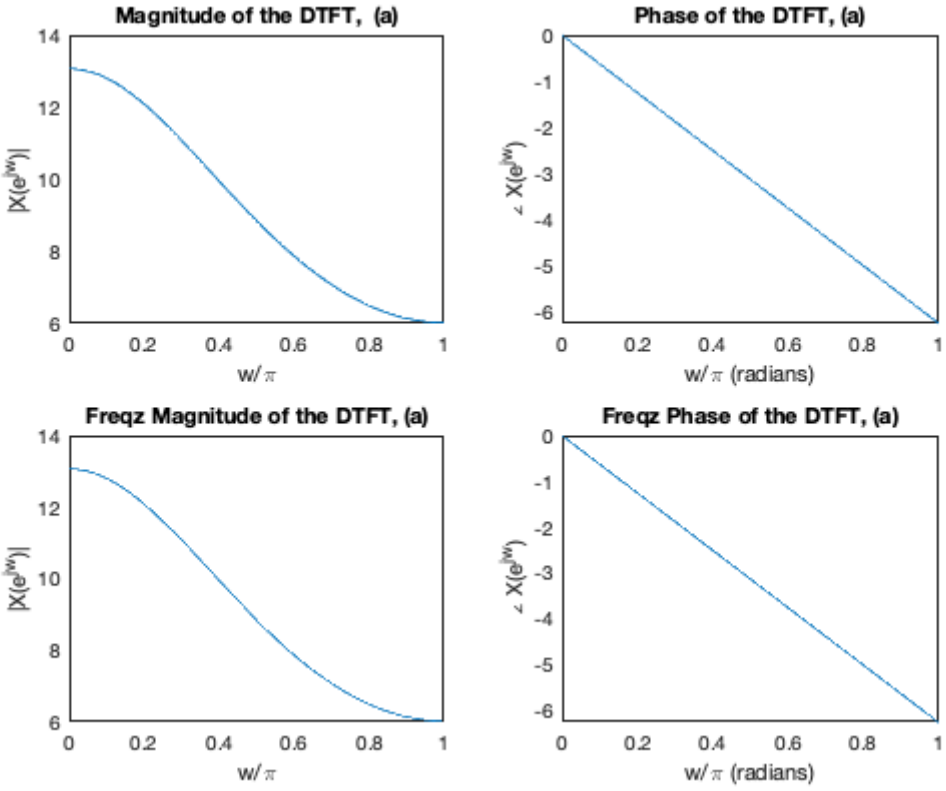
Table of Contents

..... 1
a) 1
b) 2
c) 3
d) 4
e) 5


```
% DSP 18491/691 Spring 2024 HW 2 MATLAB Problems
% This file should run perfectly without any errors
% Problem C2.1

 close all
 clear all

 w = 0:pi/100:pi;
```

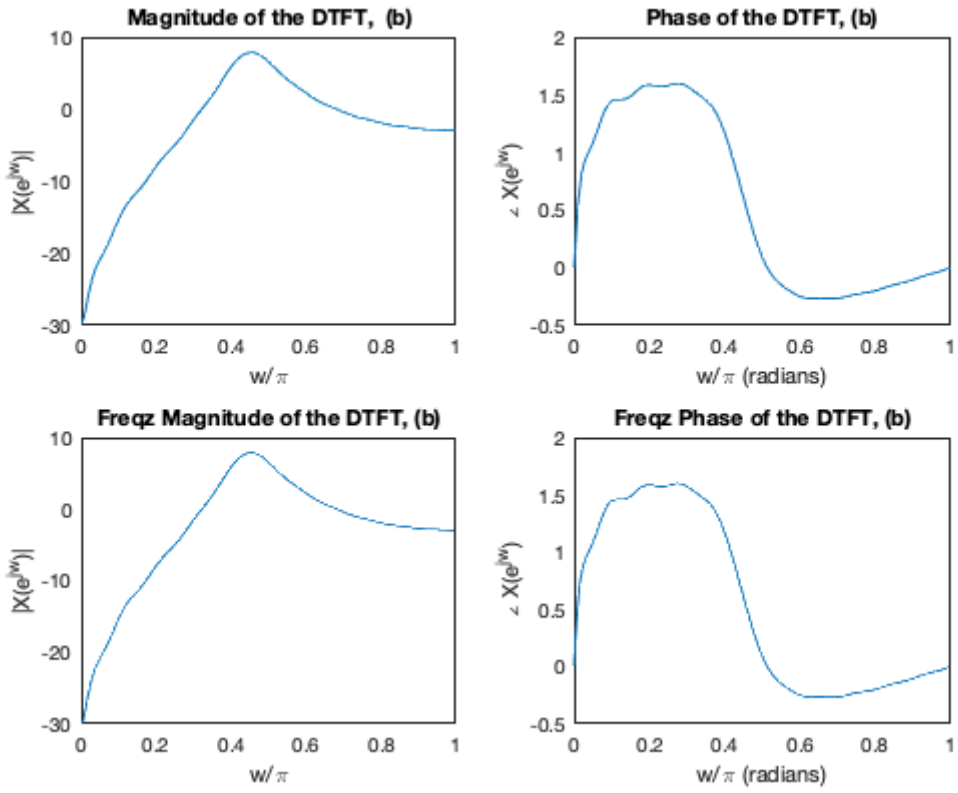
a)

```
% Part (a)

n = -10:10;
x = zeros(length(n));

pltid = ' (a)';

x=3*(5.^-(abs(n-2)));

[X] = dtft_491(x,n,w);
[X] = plot_dtft(X, w, x, n, pltid);
```



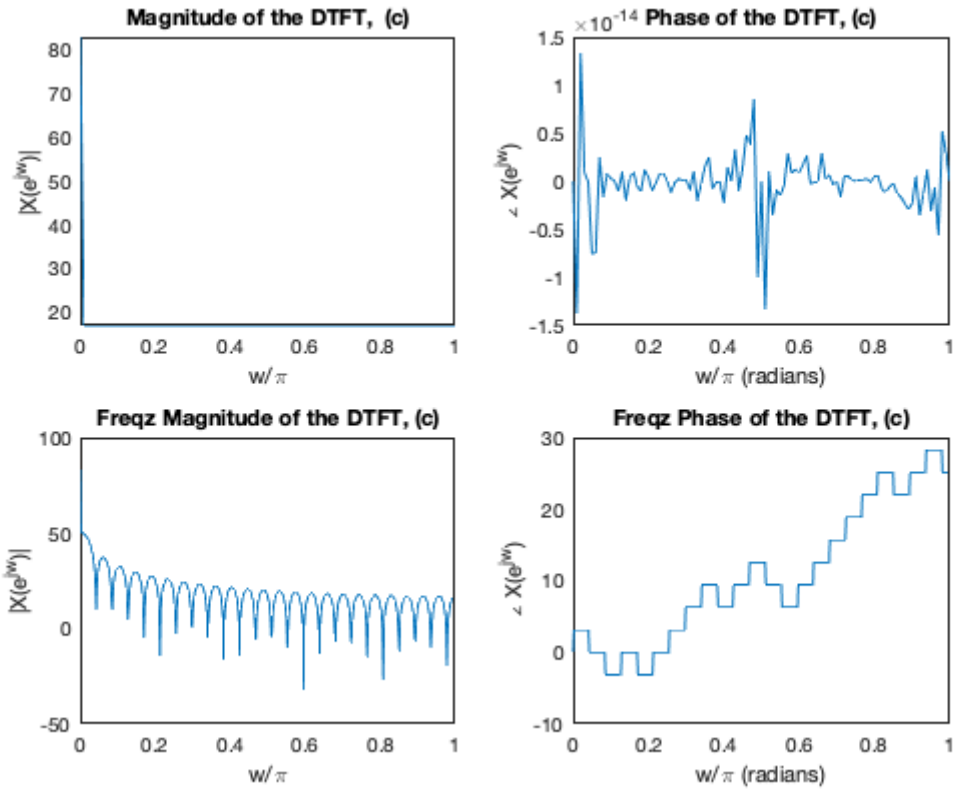
b)

```
% Part (b)

n=-20:20;
alpha = .8;
w0 = 2*pi/4.5;  % period 4.5;
phi = pi/4;
pltid = ' (b)';

x = (alpha.^n).*cos((w0*n)+phi).*(n>=0);

[X] = dtft_491(x,n,w);
[X] = plot_dtft(X, w, x, n, pltid);
```



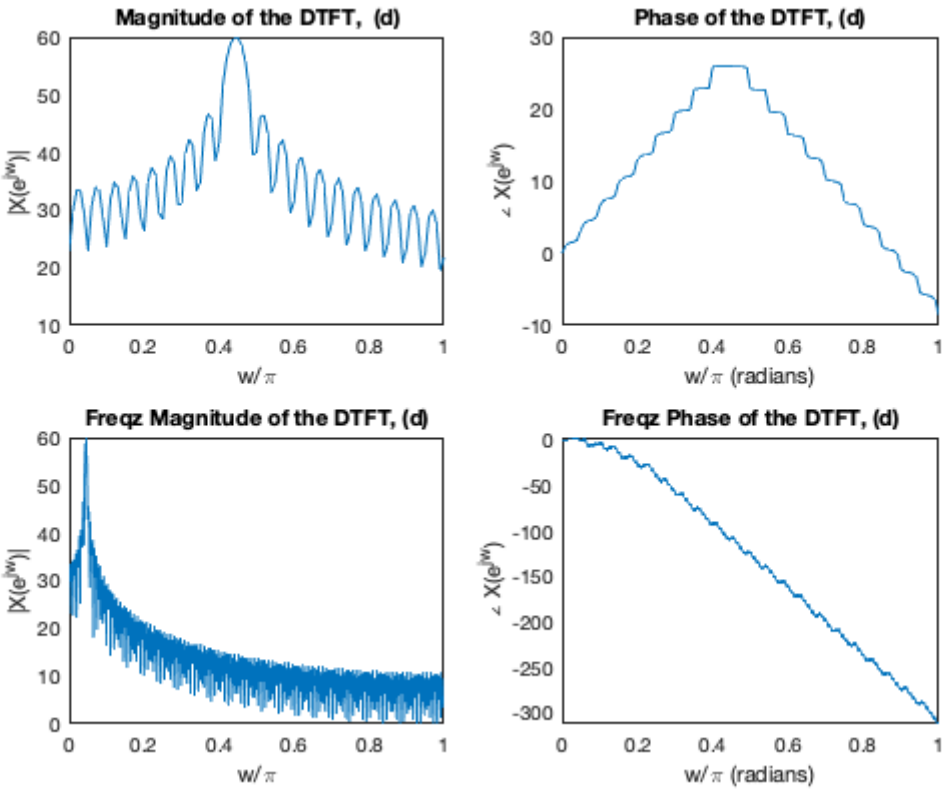
c)

```
% Part (c)

n=-1000:1000;
pltid = ' (c)';


x = 7*ones(size(n));

[X] = dtft_491(x,n,w);
[X] = plot_dtft(X, w, x, n, pltid);
```



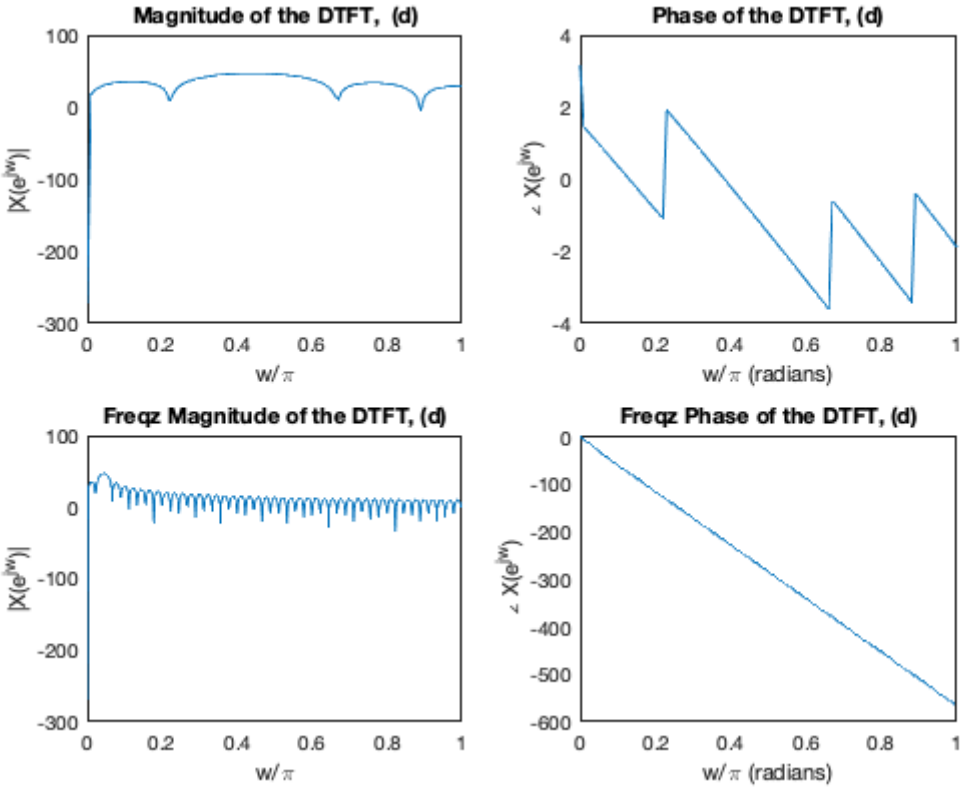
d)

```
% Part (d), same parameters as (b)

n=-20:.1:20;
w0 = 2*pi/4.5;  % period 4.5;
phi = pi/4;
A = 5;
pltid = ' (d)';

x = A.*cos((w0*n)+phi);

[X] = dtft_491(x,n,w);
[X] = plot_dtft(X, w, x, n, pltid);
```



e)

```
% Part (e), same parameters as (d)

n=-20:.1:20;
w0 = 2*pi/4.5;  % period 4.5;
phi = pi/4;
A = 5;
pltid = ' (d)';

x = A.*sin((w0*n)+phi).*((n>=0).* (n<9));

[X] = dtft_491(x,n,w);
[X] = plot_dtft(X, w, x, n, pltid);

% NOTE: The phase plots between our dtft_491 command and freqz do not always
% match those produced by freqz.  This is in part because the freqz command
% assumes that the sequence starts at n = 0, which is not always the case.
% Also, the phase plots are meaningless for frequencies at which the
% magnitude is zero (or more practically when the magnitude is very small
% compared to the maximum magnitude).
```



Published with MATLAB® R2023b

```
function [X] = dtft_491(x,n,w)
    % Computes Discrete-time Fourier Transform
    % [X] = dtft_491(x,n,w)
    %
    % X = DTFT values computed at frequencies w
    % x is a finite-duration sequence over n
    % n is the vector of "time" values over which the computation is
    % performed
    % w is a vector of frequencies used in the output
    if size(x) ~= size(n)
        error('x and n must have same shape');
    end

    X = zeros(size(w));
    for k = 1:length(w)
        X(k) = sum(x.*exp(-1j*w(k)*n));
    end
end
```

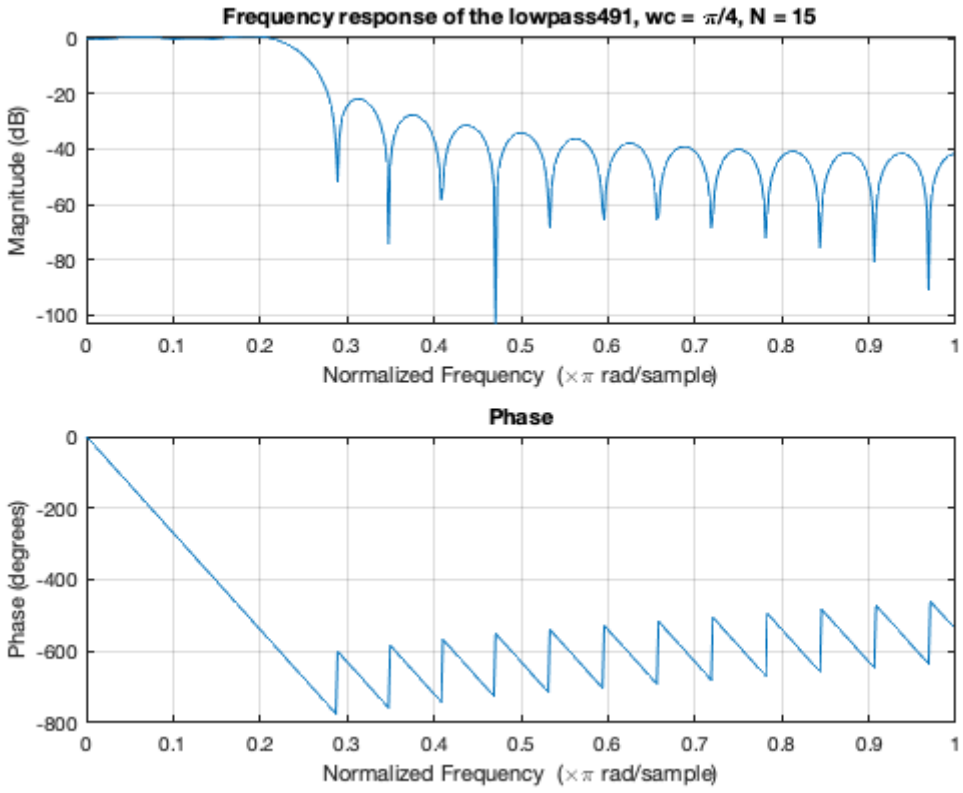
```
Not enough input arguments.

Error in dtft_491 (line 10)
    if size(x) ~= size(n)
```

Published with MATLAB® R2021b

```
% DSP 18491/691 Spring 2024 HW 2 MATLAB Problems
% This file should run perfectly without any errors
% Problem C2.2

close all
clear all
```

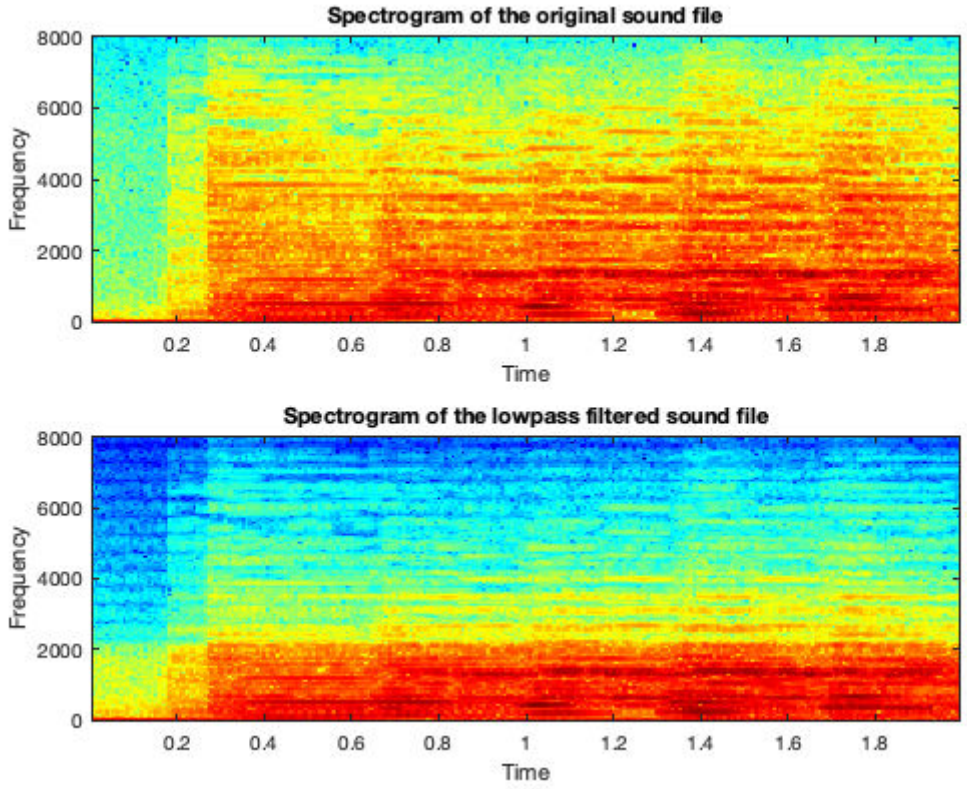
a)

```
figure
wc = pi/4;
N = 15;
h = lowpass_491(wc,N);
freqz(h,1);  % display frequency response of the LPF
title( ...
    'Frequency response of the lowpass491, wc = \pi/4, N = 15')

% ANSWER: The parameter wc determines the the cutoff frequency of the
% filter.  The parameter N determines the steepness of the transition
% between the passband and the stopband.  We will discuss these issues in
% detail later in the semester.
```



b)

```
% Considering the impact of the LPF on input audio

[x,fs] = audioread('PSO_B1short.wav');  % read in audio excerpt
x = mean(x,2); % convert it to mono

wc = pi/4;
y = conv(x,h);

soundsc(x(1:2*fs),fs)
pause(2)
soundsc(y(1:2*fs),fs)

figure
subplot(2,1,1),specgram(x(1:2*fs),[],fs)
title('Spectrogram of the original sound file')
subplot(2,1,2),specgram(y(1:2*fs),[],fs)
title('Spectrogram of the lowpass filtered sound file')

% ANSWER: The filter is a pretty mediocre filter but it does the job, sort
% of.  You can hear that the high-frequency components are a bit
% attenuated and you can also see it in the spectrograms.
```



```
function [ h ] = lowpass_491( wc, N )
% This function computes the sinc by hand for the arguments in question

n = 0:2*N;
h = sin(wc.*(n-N))./(pi*(n-N));
h(N+1) = wc/pi;      % inserting the solution for the 0/0 case by hand

end
```

```
Not enough input arguments.

Error in lowpass_491 (line 4)
n = 0:2*N;
```

Published with MATLAB® R2021b